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Pyrolytic carbon for MEMS string resonantors

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In order to achieve high resonance frequencies and quality factors of pyrolytic carbon MEMS string resonators the resonator material needs to have a large tensile stress. In this study, the influence of pyrolysis temperature, dwell time and ramping rate on the residual stress in thin pyrolytic carbon films is investigated with the bending plate method. The results show that the pyrolysis temperature is the most important parameter for tailoring the residual stress, with a transition from tensile stress at temperature below 800ºC to compressive stress at temperatures above 800ºC. Two kinds of photoresist: positive (AZ5214E) and negative (SU-8) and different pyrolysis conditions are used to fabricate pyrolytic carbon string resonators at variable pyrolysis conditions. The best performance is obtained for devices with a length of 400 mm fabricated at a pyrolysis temperature of 700ºC, ramping rate of 30ºC/min and 10 min dwell time corresponding to the conditions for maximum tensile stress in pyrolytic carbon thin films. The optimized pyrolytic carbon string resonators have resonant frequencies above 300 kHz and quality factors (Q) in the order of 10^4, which is suitable for their application as nanomechanical sensors. One of these application is that using the nanomechanical infrared spectroscopy (NAM-IR) based on the photothermal response of a nanomechanical resonator, which enables the chemical analysis of picograms of analyte in only a few minutes.